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SURVEILLANCE REPORT

Integrated Respiratory Virus Risk Indicators for Ontario: October 29, 2023 to November 11, 2023

Published: November 3, 2023

Introduction

This report provides short-term projections of SARS-CoV-2, influenza, and respiratory syncytial virus (RSV) activity and risk of related severe viral respiratory disease (i.e., hospitalizations related to the three viruses) in the pediatric (<18 years) and general adult (18-64 years) populations in Ontario. The "nowcast" estimation methodology[1] used to create these indicators relies on Public Health Ontario's (PHO) data reported up to **October 28, 2023**.

The projections provided in this report are intended to provide situational awareness of the near-term changes in respiratory virus activity in the province. The thresholds are not intended to be used to determine when public health actions/measures should be taken. These projections should be used in combination with context-specific indicators (e.g., the group at risk, current trajectory of trends, immunization coverage), consideration of local factors (e.g., health care capacity and access to care), and other measures for assessing respiratory virus activity (e.g., wastewater concentration for SARS-CoV-2, hospital admissions). For more information on respiratory virus surveillance activity in Ontario, please visit the Ontario Respiratory Virus Tool.[2]

Highlights

- Over the next two weeks, the following changes are projected for SARS-CoV-2, influenza, and RSV activity in Ontario:
    - SARS-CoV-2 activity is projected to **increase** (Figures 1a, 1b).
    - Influenza activity is projected to **remain stable** (Figures 2a, 2b).
        - Influenza activity is currently sporadic in the province; thus, any projected changes in direction should be interpreted with caution.
    - RSV activity is projected to **increase** (Figures 3a, 3b).
- The risk of related severe respiratory virus illness for the most recent week of available data is **very high** in the pediatric population and **high** in the general adult population. Over the next two weeks:
    - The risk of severe illness among the pediatric population is projected to **increase** (Figure 4).
    - The risk of severe illness among the general adult population is projected to **remain stable** (Figure 5)**.**

Interpretation Notes

When interpreting these indicators, the following should also be considered:

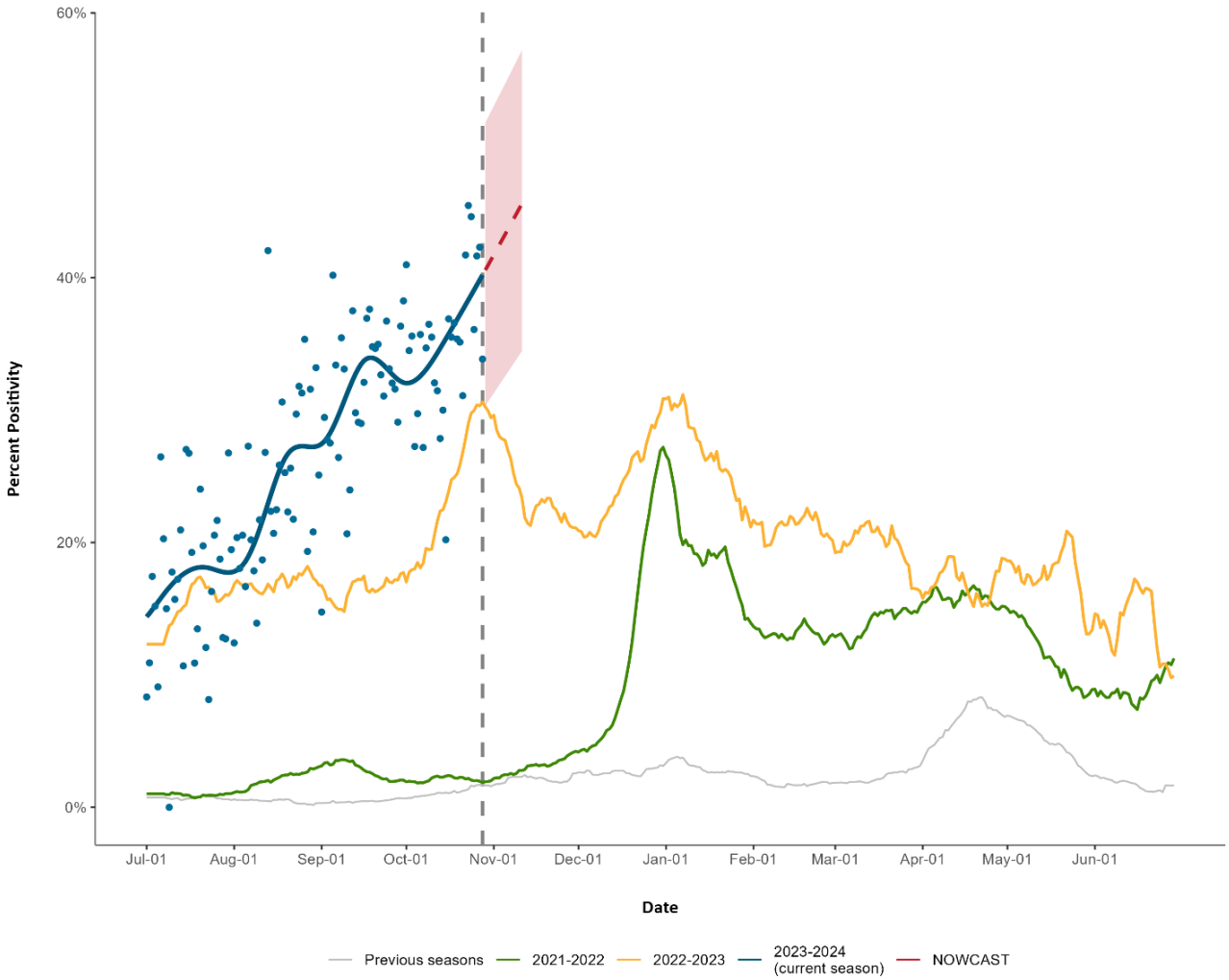
- SARS-CoV-2, influenza, and RSV activity should be assessed independently due to differences in provincial testing strategy, populations eligible for testing, and data collection and entry requirements. Refer to the Data and Methodological Caveats for further details regarding testing eligibility.
    - Current estimates of the risk of severe disease in the general adult population should be interpreted with caution as SARS-CoV-2 percent positivity values are higher than in previous years. This may contribute to higher estimates of risk when compared to observed hospitalization patterns.
- These estimates are primarily informed by percent positivity (the number of tests performed that were positive for the virus), obtained from PHO's Laboratory Information Management System. There are the main caveats regarding these data:
    - There are significantly more SARS-CoV-2 tests performed compared to influenza and RSV tests.
    - Not all respiratory virus tests performed in Ontario are conducted by PHO. For example, PHO does not capture tests performed by Ontario's major pediatric hospitals, which may impact the generalizability of RSV estimates in the pediatric population.
    - Testing performed by PHO is skewed towards outbreak detection as well as towards older individuals, particularly those aged 65 years and older who are not included in this report. As a result, the number of tests performed in certain age groups can sometimes be low, which may impact the stability of age group specific percent positivity estimates derived from PHO data.
- All data and projections exclude adults 65 years of age and older. Given differences in testing eligibility and hospital admission patterns for older adults in congregate care facilities (e.g., long-term care homes), compared to the general adult population, indicators specific to older adult populations should be considered when assessing viral activity and disease in these populations.
- Trends should be interpreted with caution as the most recent period of data may be subject to reporting and/or data entry lags, which may impact the accuracy of projections. Changes in testing algorithms over time may also impact the accuracy of projections.
    - Assessments of increases or decreases in trends are based on whether projections indicate any change in activity or disease risk in the next two-week period. These criteria may differ from the weekly indicator changes outlined on the "Summary" Tab in the Ontario Respiratory Virus Tool, [2] which are determined by considering a combination of indicators (see Technical Notes, Ontario Respiratory Virus Tool).
- This report does not provide estimates of the expected number of cases or hospitalizations due to COVID-19, influenza, or RSV.

Projections of Viral Respiratory Activity

Pathogen-specific activity was determined from patterns in percent positivity, as reported by PHO, and projections were produced using a "nowcast" statistical model.

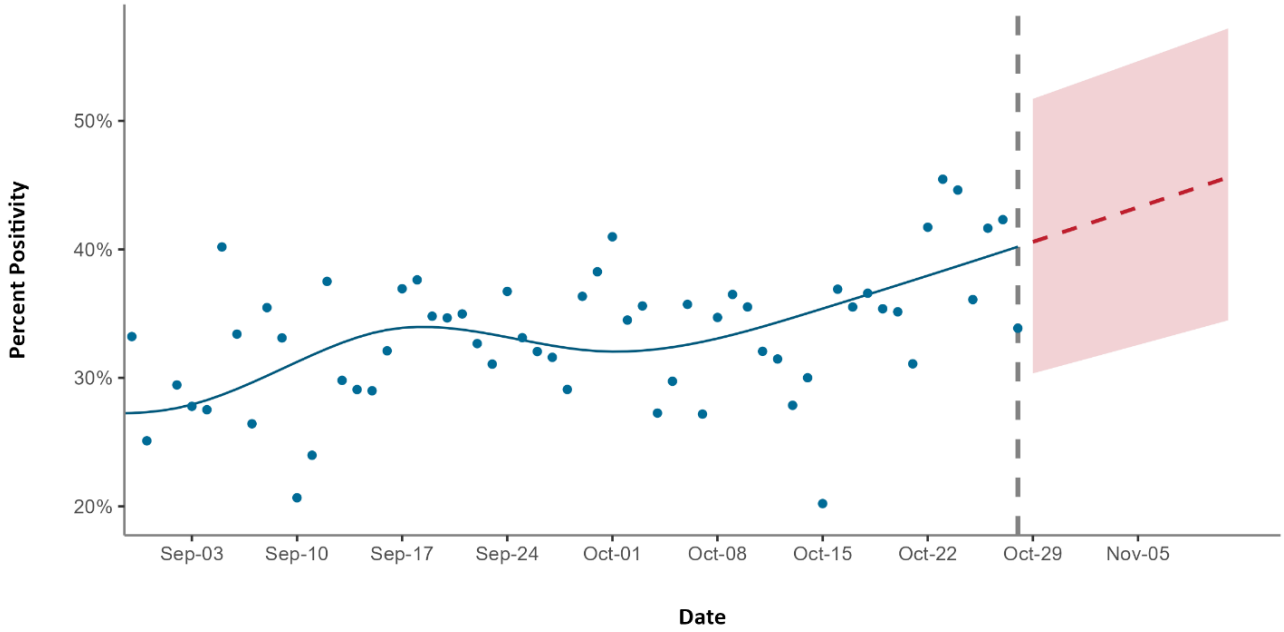
Further details on the data sources and statistical approaches used in this report are provided in the Technical Notes and Appendix A.

Figure 1a: Historic and projected SARS-CoV-2 activity (percent positivity) in Ontario



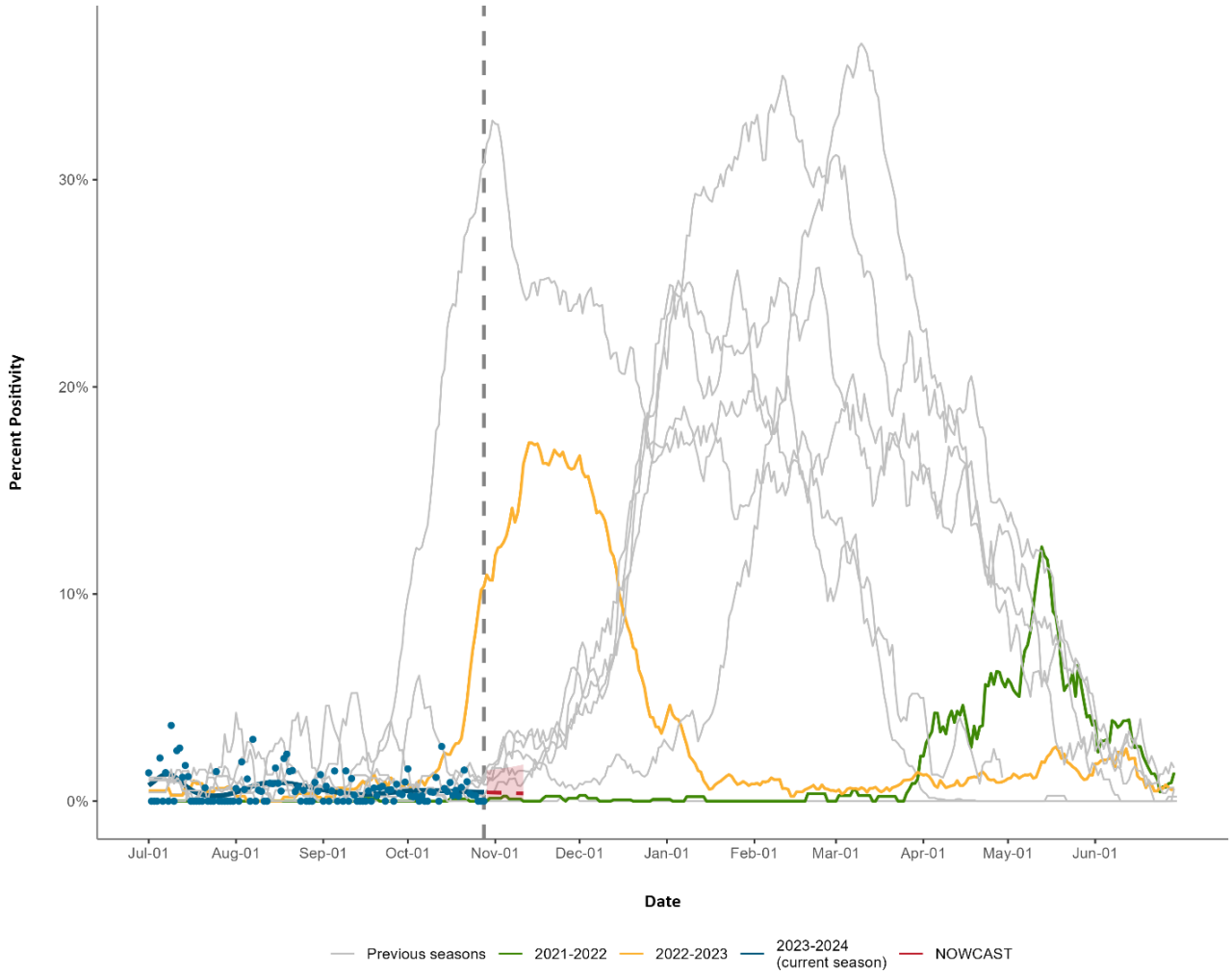
Note: Blue line shows the smoothed daily observed percent positivity (blue dots) for the 2023-24 season among Ontarians less than 65 years of age. The grey vertical dashed line indicates the most recent day with observed data. The dashed red line represents the estimated viral activity (percent positivity) from nowcast projection modelling, which makes projections using the past two years of daily PHO laboratory data in a generalized additive model (GAM). The light red shaded area represents the 95% prediction interval around model estimates. The yellow line shows the smoothed daily observed percent positivity for the 2022-23 season and the green line shows the 2021-22 season. The grey line shows the smoothed daily percent positivity for earlier seasons (i.e., 2020-21). Notably, surveillance periods are shown starting on July 1st of each year to align with annual influenza and RSV activity.
Data Source: PHO Laboratory Information Management System

Figure 1b: Magnified area of recent and projected SARS-CoV-2 activity (percent positivity) in Ontario



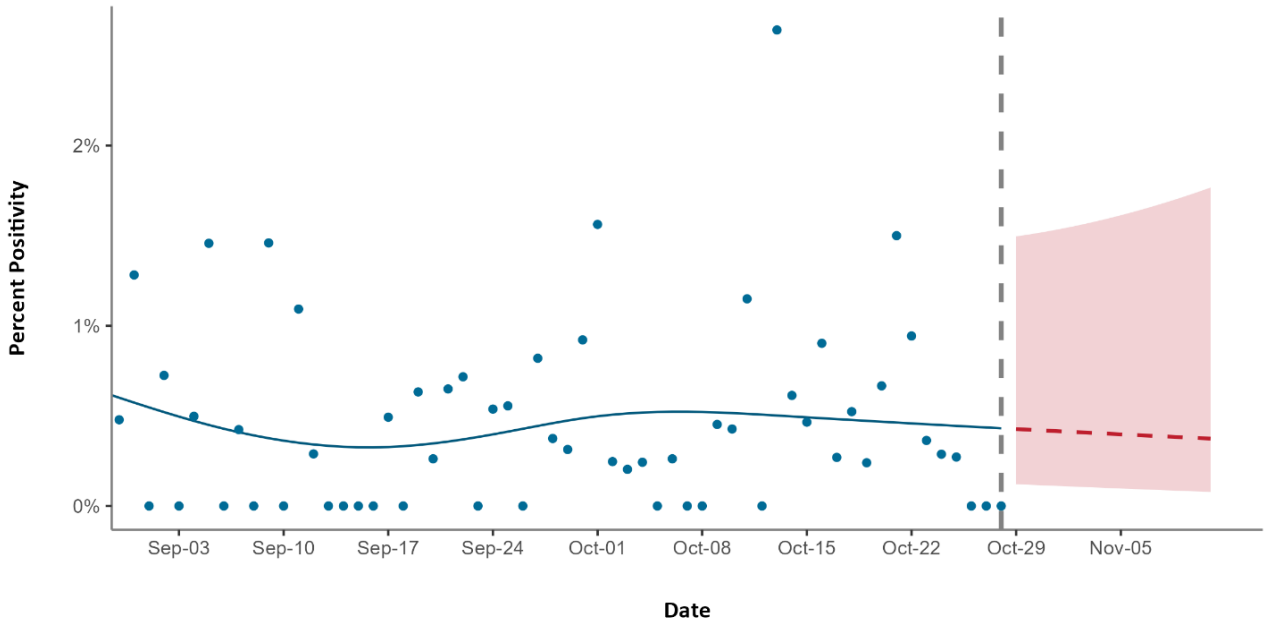
Note: This figure shows a subset of the data presented in Figure 1a above for the 2023-24 (current) season. It is comprised of the most recent eight weeks of data and the two-week projections.
Data Source: PHO Laboratory Information Management System

Figure 2a: Historic and projected influenza activity (percent positivity) in Ontario



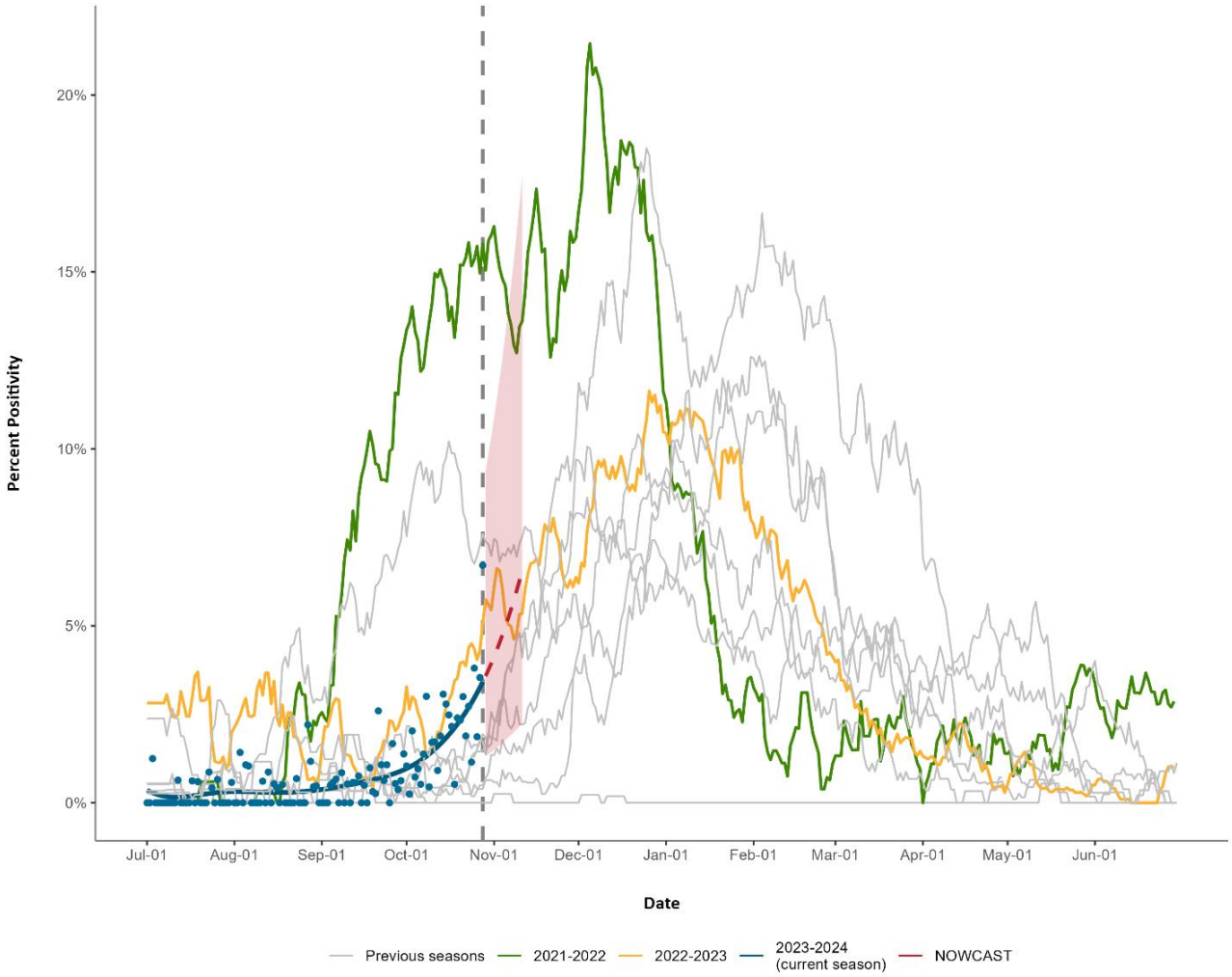
Note: Blue line shows the smoothed daily observed percent positivity (blue dots) for the 2023-24 season among Ontarians less than 65 years of age. The grey vertical dashed line indicates the most recent day with observed data. The dashed red line represents the estimated viral activity (percent positivity) from nowcast projection modelling, which makes projections using the past two years of daily PHO laboratory data in a generalized additive model (GAM). The light red shaded area represents the 95% prediction interval around model estimates. The yellow line shows the smoothed, daily observed percent positivity for the 2022-23 season and the green line shows the 2021-22 season. The grey lines show the smoothed daily percent positivity for earlier seasons (i.e., 2014-15 through 2020-21). Notably, surveillance periods are shown starting on July 1st of each year to align with annual influenza and RSV activity.
Data Source: PHO Laboratory Information Management System

Figure 2b: Magnified area of recent and projected influenza activity (percent positivity) in Ontario



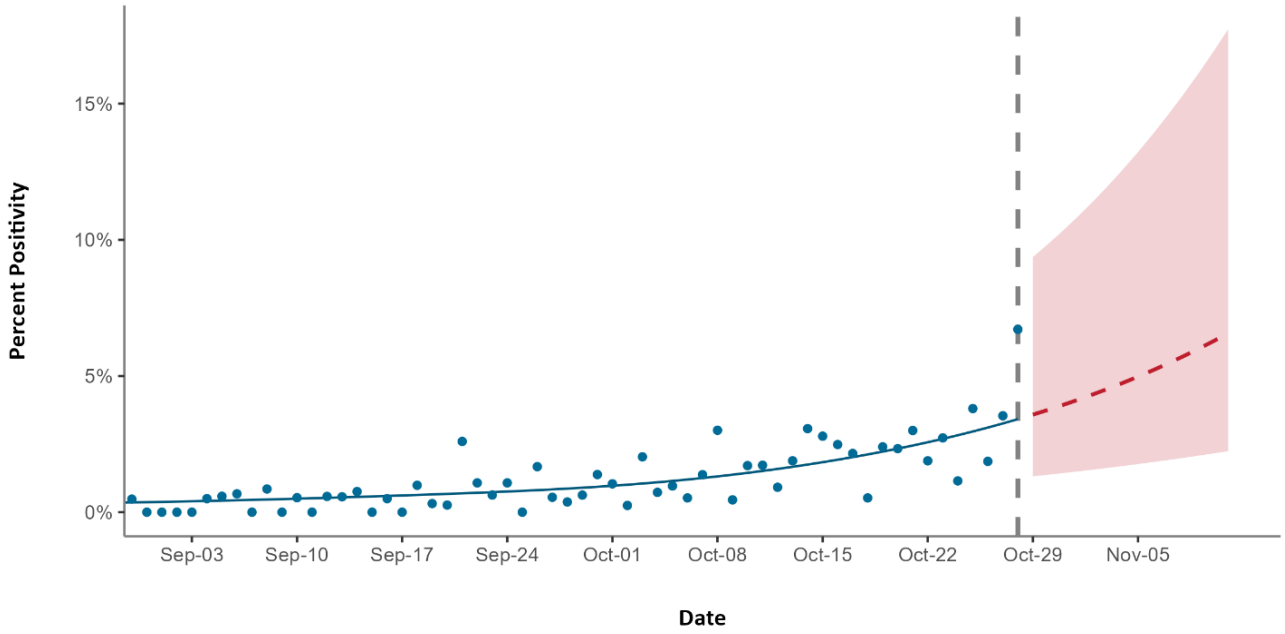
Note: This figure shows a subset of the data presented in Figure 2a above for the 2023-24 (current) season. It is comprised of the most recent eight weeks of data and the two-week projections.
Data Source: PHO Laboratory Information Management System

Figure 3a: Historic and projected RSV activity (percent positivity) in Ontario



Note: Blue line shows the smoothed daily observed percent positivity (blue dots) for the 2023-24 season among Ontarians less than 65 years of age. The grey vertical dashed line indicates the most recent day with observed data. The dashed red line represents the estimated viral activity (percent positivity) from nowcast projection modelling, which makes projections using the past two years of daily PHO laboratory data in a generalized additive model (GAM). The light red shaded area represents the 95% prediction interval around model estimates. The yellow line shows the smoothed, daily observed percent positivity for the 2022-23 season and the green line shows the 2021-22 season. Grey lines show the smoothed daily percent positivity for older seasons (i.e., 2014-15 through 2020-21). Notably, surveillance periods are shown starting on July 1st of each year to align with annual influenza and RSV activity.
Data Source: PHO Laboratory Information Management System

Figure 3b: Magnified area of recent and projected RSV activity (percent positivity) in Ontario

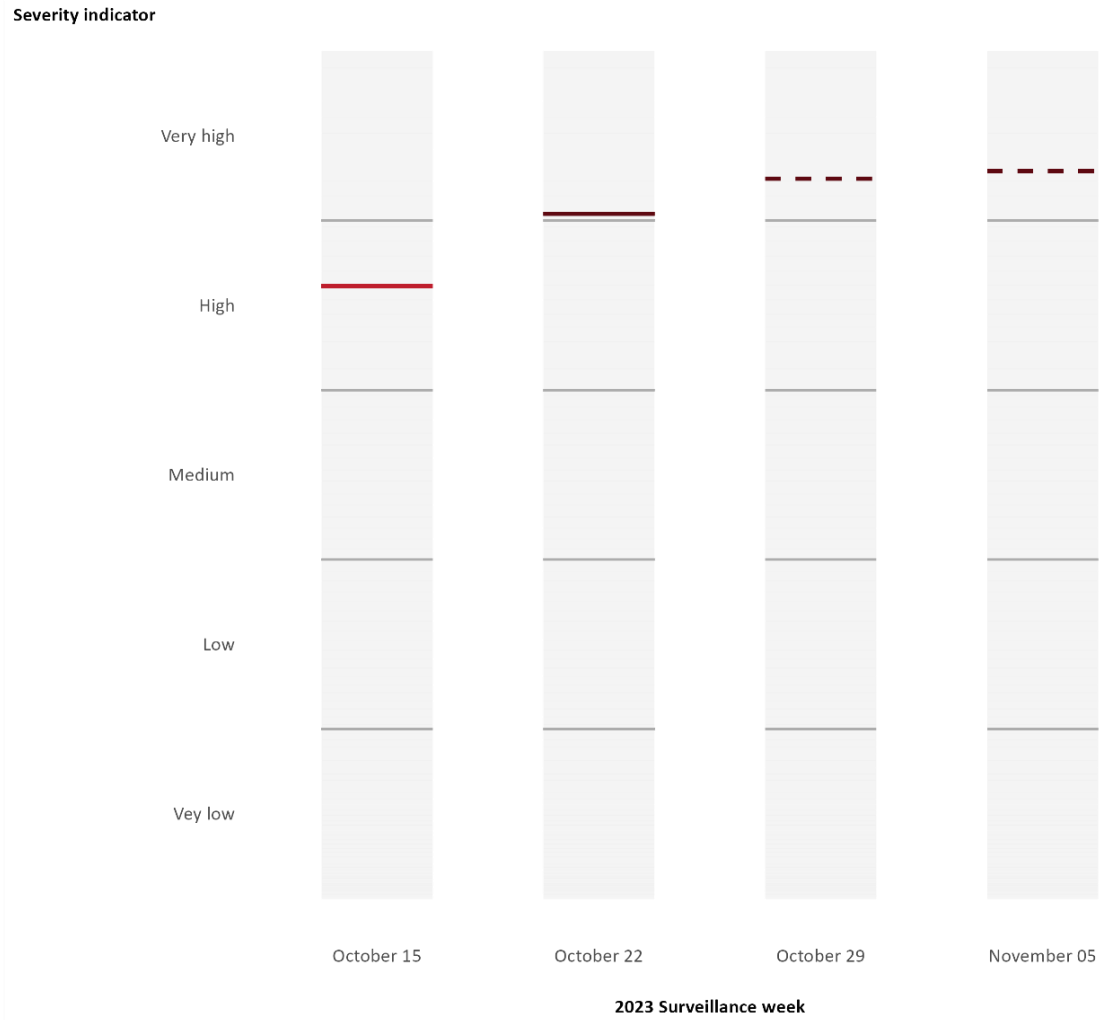


Note: This figure shows a subset of the data presented in Figure 3a above for the 2023-24 (current) season. It is comprised of the most recent eight weeks of data and the two-week projections.
Data Source: PHO Laboratory Information Management System

Projections of Severe Viral Respiratory Disease

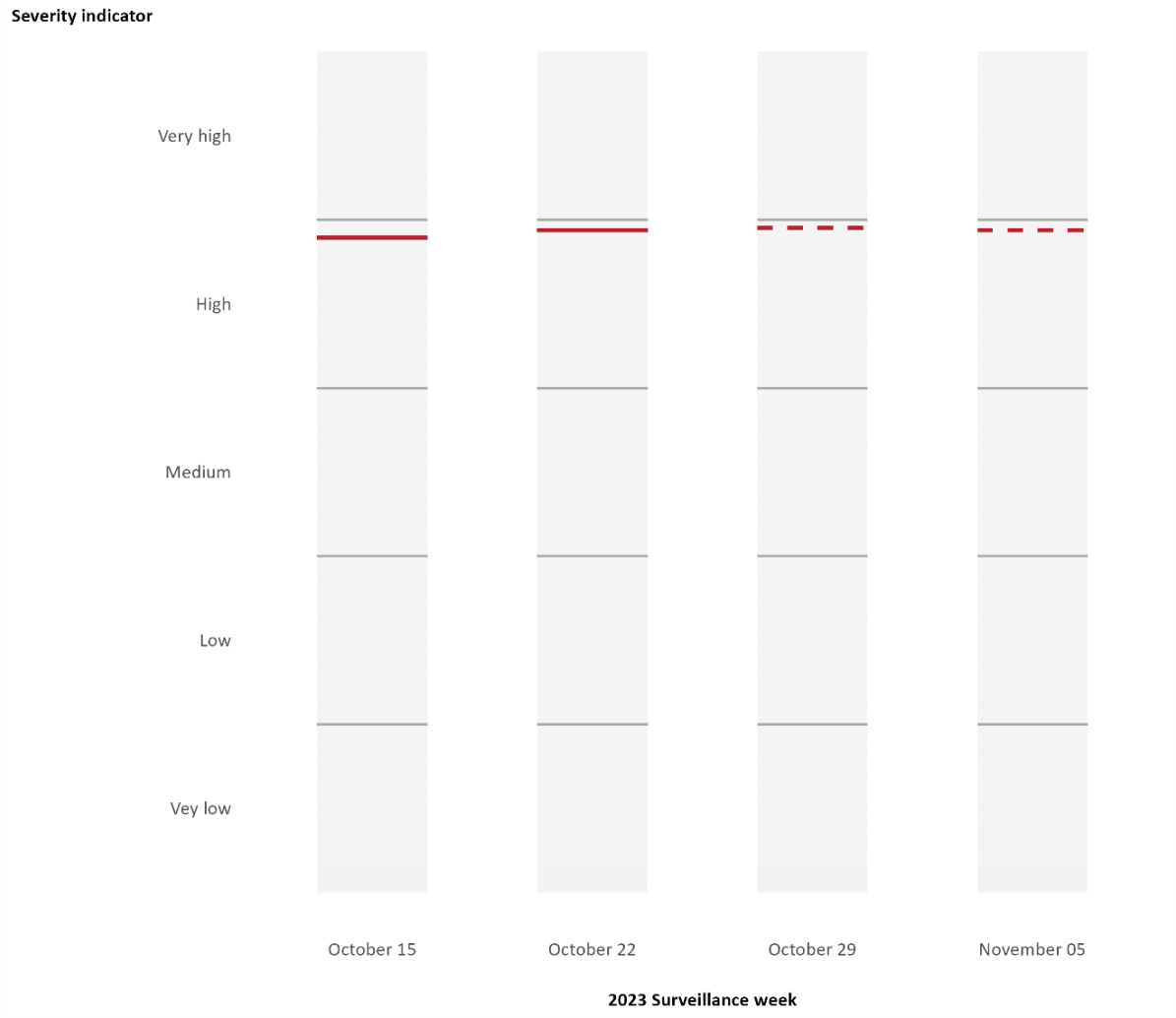
Weekly indicators of the current and projected risk of severe viral respiratory disease (i.e., requiring hospitalization) among pediatric (i.e., <18 years) and the general adult population (i.e., 18-64 years) were determined using a combination of data sources and statistical approaches as outlined in the methods section below. Further details are provided in the Technical Notes and Appendix A. Additional data are included in Appendix B.

Figure 4: Estimated level of severe viral respiratory disease risk in the pediatric population (<18 years) during the most recent two-week period of available data* and projected risk levels for the next two weeks**



Note: Dark grey horizontal lines are the category thresholds and are based on historic levels of risk from a reference period of low incidence that occurred from June 1, 2023 through July 31, 2023. The category thresholds are: very low, low, moderate, high, and very high risk. Coloured horizontal bars indicate the observed (solid line) or projected (dashed line) maximum daily risk in a given week. When shown, dark green lines represent very low risk, green lines represent low risk, yellow lines represent medium risk, red lines represent high risk, and dark red lines represent very high risk. Refer to the Appendices for additional details.
*Weeks starting on October 15 and October 22
**Weeks starting on October 29 and November 5
Data Sources: PHO Laboratory Information Management System; Ministry of Health Bed Census Data

Figure 5: Estimated level of severe viral respiratory disease risk in the general adult (18-64 years) population during most recent two-week period of available data* and projected risk levels for the next two weeks**



Note: Dark grey horizontal lines are the category thresholds and are based on historic levels of risk from a reference period of low incidence that occurred from June 1, 2023 through July 31, 2023. The category thresholds are: very low, low, moderate, high, and very high risk. Coloured horizontal bars indicate the observed (solid line) or estimated (dashed line) maximum daily risk in a given week. When shown, dark green lines represent very low risk, green lines represent low risk, yellow lines represent medium risk, red lines represent high risk, and dark red lines represent very high risk. Refer to the Appendices for additional details.
*Weeks starting on October 15 and October 22
**Weeks starting on October 29 and November 5
Data Sources: PHO Laboratory Information Management System; Ministry of Health Bed Census Data

Summary of Methods

Indicators of Pathogen-Specific Community Viral Respiratory Activity

- For the three pathogen-specific indicators of community viral activity, generalized additive models (GAMs) were applied to observed daily pathogen- and age-specific PHO laboratory testing data (restricted to individuals less than 65 years of age) for the past two-year period to project the daily pathogen-specific percent positivity forward 14 days, along with 95% prediction intervals.
- Specifically, GAMs were fit using cubic splines, with knots located 14 days apart. The most recent knot is located 14 days from the most recent date of observed data included in the model, meaning that the positivity projection is based on a linear interpolation of percent positivity.

Indicators of Severe Viral Respiratory Disease Risk

- The projected pathogen- and age-specific percent positivity values obtained from the model described above are included in a previously calibrated generalized linear model (GLM) (see Appendix A) to estimate severe viral respiratory disease risk (for all the three viruses combined) specific to the pediatric and general adult populations. Daily relative risk estimates, along with 95% prediction intervals, are reported in Appendix B.
- For each age-group specific indicator calculated above, quintile thresholds were calculated from historic risk levels (i.e., observed hospitalization counts for COVID-19, influenza, and RSV) representing very low, low, medium, high, and very high risk of severe disease.
- See Appendix A for additional methodological details.

Technical Notes

Data Sources

Public Health Ontario (PHO):

- PHO respiratory virus testing data were extracted from the PHO Laboratory Information Management System on November 1, 2023, at 9 a.m., and include data reported up to October 28, 2023.

Ministry of Health (MOH) Bed Census (I9):

- Hospital bed occupancy data were obtained from the Ministry of Health on November 1, 2023 at 9 a.m.

Data and Methodological Caveats

- Additional data caveats and methods are available in the following resources:
    - Interpretation Notes of this report
    - Technical Notes of the Ontario Respiratory Virus Tool[2]
        - Refer to the “Lab Testing” tab of Ontario Respiratory Virus Tool to further explore the laboratory data used in this report.

- COVID-19 and influenza are diseases of public health significance in Ontario and cases are therefore reportable to the province as per Ontario Regulation (O. Reg.) 135/18 (Designation of Diseases) and amendments under the Health Protection and Promotion Act (HPPA).[3,4] Other respiratory viruses are only reportable as respiratory infection outbreaks in institutions and public hospitals and therefore testing and case data are limited.
- Percent positivity is calculated from the number of positive tests and the total number of tests performed in a given time period for individuals less than 65 years of age. Testing eligibility for SARS-CoV-2, influenza, and RSV differ along with the number of tests performed. For the most up to date information on testing eligibility please refer to the provincial testing guidance for SARS-CoV-2 and Public Health Ontario laboratory's guidance for influenza and RSV.[5,6]
- For the most up to date information on seasonal respiratory viruses tested at PHO, please refer to the PHO's laboratory respiratory testing algorithm.[6]
- Decisions regarding public health action and/or infection prevention and control should not solely rely on percent positivity levels as context specific indicators (e.g., the group at risk, current trajectory of trends, immunization coverage, transmissibility, severity, risk tolerance, as well as local factors such as health care capacity and access to care, current measures in place, etc.) should also be considered.
- Public Health Ontario Laboratory Information Management System data are based on routine testing for seasonal respiratory viruses and SARS-CoV-2 for select population groups, including:
    - Hospitalized individuals, including those in intensive care, and symptomatic residents of institutions (e.g. retirement homes, long term care homes, correctional facilities, etc.).
    - The first four symptomatic individuals associated with an outbreak investigation.
    - Symptomatic individuals, 18 years old and younger, who receive care in an emergency department.[6]
    - Individuals attending physician offices that are part of the Sentinel Practitioner Surveillance Network.[7]
- As of November 14, 2022, PHO's testing algorithm for seasonal respiratory viruses has been updated to accept samples from symptomatic health care workers from institutional settings.
- PHO will consistently assess the accuracy of these models to ensure accurate and timely projections of respiratory virus activity in Ontario. Thus, refinements to the models and recalibration activities may occur throughout the respiratory virus season with updates reflected in future reports. Considerations for updating models may include: evolving data availability, emerging variants, and emerging seasonal patterns and trends as we get further into the respiratory virus season.

References

1. Albani VVL, Albani RAS, Massad E, and Zubelli JP. 2022. Nowcasting and forecasting COVID-19 waves: the recursive and stochastic nature of transmission. R Soc Open Sci. 2022;9(8):220489. Available from: doi: 10.1098/rsos.220489.

2. Ontario Agency for Health Protection and Promotion (Public Health Ontario). Technical notes: Ontario respiratory virus tool [Internet]. Toronto, ON: King's Printer for Ontario; 2023 [modified 2023 Sep 08; cited 2023 Sep 08]. Available from: https://www.publichealthontario.ca/-/media/data-files/respiratory-virus-tool-technical-notes.pdf?la=en

3. *Designation of Diseases*, O Reg 135/18. Available from: https://www.ontario.ca/laws/regulation/180135

4. *Health Protection and Promotion Act*, RSO 1990, c H.7. Available from: https://www.ontario.ca/laws/statute/90h07

5. Ontario. Ministry of Health; Ontario. Ministry of Long-Term Care. COVID-19: guidance for the health sector [Internet]. Toronto, ON: King's Printer for Ontario; 2022 [modified 2022 Sep 06; cited 2022 Sep 13]. Available from: https://www.health.gov.on.ca/en/pro/programs/publichealth/coronavirus/2019_guidance.aspx

6. Ontario Agency for Health Protection and Promotion (Public Health Ontario). Test information index: respiratory viruses (including influenza) [Internet]. Toronto, ON: King's Printer for Ontario; 2022 [cited 2023 Sept 13]. Available from: https://www.publichealthontario.ca/en/Laboratory-Services/Test-Information-Index/Virus-Respiratory

7. Ontario Agency for Health Protection and Promotion (Public Health Ontario). Sentinel practitioner surveillance network — influenza vaccine effectiveness program [Internet]. Toronto, ON: Queen's Printer for Ontario; 2021 [modified 2019 Nov 21; cited 2022 Dec 01]. Available from: https://www.publichealthontario.ca/en/Health-Topics/Immunization/SPSN

Appendix A: Technical Summary of Statistical Methods

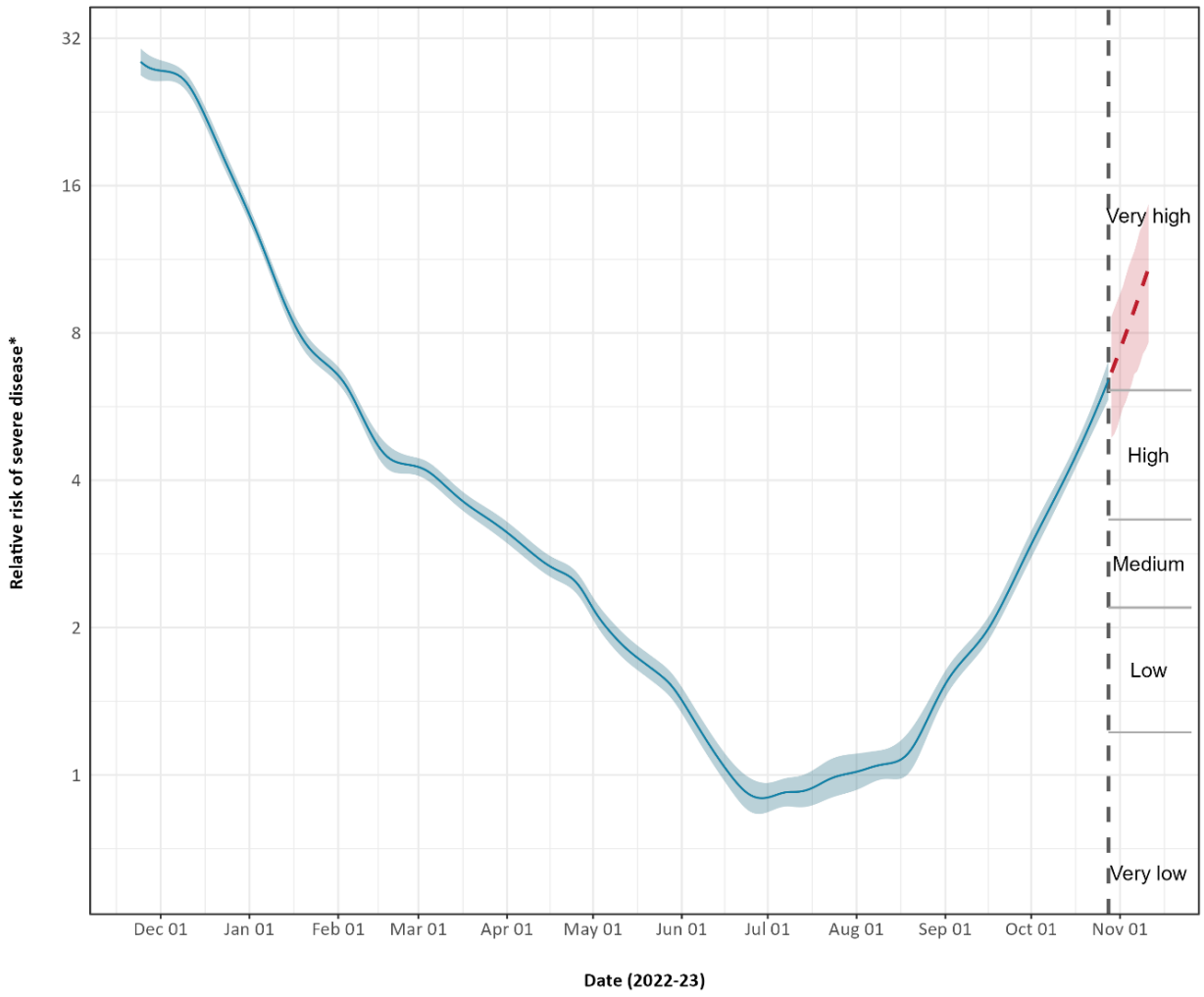
To ensure estimates of disease severity risk accurately reflected observed trends in severe viral respiratory disease (i.e., hospitalizations), and to allow pathogen-specific percent positivity trends to be appropriately combined into a single indicator of age-specific severe disease risk, the following modelling approach was taken.

- Total daily age-specific hospital admissions for COVID-19, influenza (A and B), and RSV were identified from Ministry of Health Bed Census Data from the earliest date for which data for all three diseases was collected (i.e., November 24, 2022).
    - Notably, we assumed these pathogen-specific hospitalizations were an accurate indicator of severe viral respiratory disease; however, this may be an underestimate of the true level of severe viral respiratory disease in the population as some individuals with severe disease may not seek hospital care or may not be captured in the bed census data.
- In addition to the age stratified, pathogen-specific, percent-positivity models described above, an age-stratified generalized linear model (GLM) was developed using daily pathogen-specific percent positivity and annual and biannual Fourier seasonality terms (to account for underlying viral respiratory disease trends) as independent variables. The total age-specific number of hospitalizations reported for COVID-19, influenza, and RSV, i.e., a proxy for severe viral respiratory disease, was used as the dependent variable.
    - The calibration model was based on percent positivity and hospitalization data for the period November 24, 2022 through October 28, 2023, as this is when hospitalization data for all three pathogens was readily available at the time of calibration.
    - Several model specifications were considered, including different methods to account for seasonality (e.g., number of Fourier terms), approaches for implementing smoothing splines (e.g., cubic regression), and model functional forms (e.g., GLM, GAM). The best fitting model was defined as having the smallest prediction error when compared against a testing data set which were not included when training the model, i.e., the last two weeks of observed data were held back as testing data set.
    - The coefficients obtained from this previously calibrated model are subsequently applied to the projected virus-specific percent positivity data (described above) to obtain estimates of the projected risk of severe disease (i.e., hospitalization) in the following 14-day period.
    - To ensure the continued accuracy of these calibration weights, ongoing calibration activities will occur throughout the respiratory virus season (with any updates to be documented in future reports).
- The relative risk of severe disease was calculated relative to a period with historically low severe viral respiratory disease risk. Specifically, relative risk was determined relative to the observed average combined daily number of hospitalizations related to COVID-19, influenza, and RSV occurring between June 1, 2023 and July 31, 2023 in each age group.
    - For the pediatric population, the average number of new hospitalizations during this period was 12.3 per day.
    - For the adult population, the average number of new hospitalizations during this period was 282.3 per day.

- Threshold values (i.e., very low, low, medium, high, very high) align with quintile intervals calculated from the above historic severe disease relative risk estimates (i.e., for the period November 24, 2022 through October 21, 2023).
    - For the pediatric population, these threshold values were 1.2, 2.2, 3.3, and 6.1, respectively.
    - For the adult population, these threshold values were 1.2, 2.1, 3.5, and 4.6, respectively.

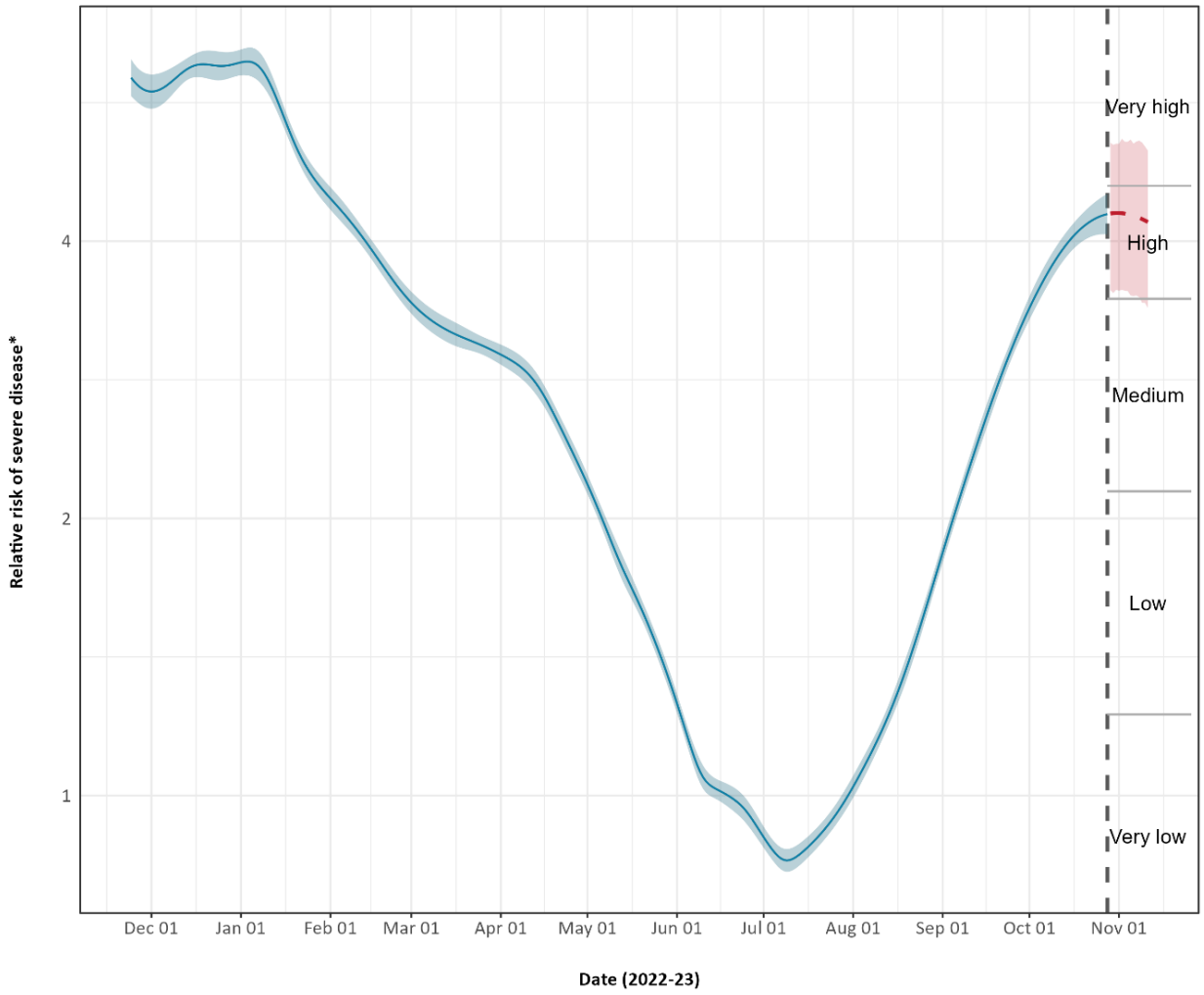
Appendix B: Daily Severe Viral Respiratory Disease Risk

Supplementary Figure 1a: Estimated level of severe viral respiratory disease risk in the pediatric (<18 years) population, using nowcast model up to November 11, 2023



Note: Blue curve represents the estimated relative risk of severe disease from nowcast modelling, which uses the past two years of daily PHOL data in a generalized linear model. Dashed red line represents the projected viral activity (percent positivity). The vertical grey dashed line indicates the most recent day with observed data, after which projections are presented. The light blue shaded area represents the 95% confidence interval and the red shaded area represents the 95% prediction interval. The grey horizontal lines represent the historical threshold values, as indicated (i.e., very low, low, moderate, high, or very high relative risk of severe disease).
*The y-axis uses a log scale and shows the risk of severe disease relative to a reference period of low incidence that occurred from June 1, 2023 through July 31, 2023. A relative risk equal to 1 indicates similar risk of severe viral disease as the reference period; a relative risk greater than 1 indicates higher risk of severe disease and a relative risk of less than 1 indicates lower risk of severe disease.
Data Sources: PHO Laboratory Information Management System; Ministry of Health Bed Census Data

Supplementary Figure 1b: Estimated level of severe viral respiratory disease risk in the general adult (18-64 years) population, using nowcast model up to November 11, 2023



Note: Blue curve represents the estimated relative risk of severe disease from nowcast modelling, which uses the past two years of daily PHOL data in a generalized linear model. Dashed red line represents the projected viral activity (percent positivity). The vertical grey dashed line indicates the most recent day with observed data, after which projected estimates are presented. The light blue shaded area represents the 95% confidence interval and the red shaded area represents the 95% prediction interval. The grey horizontal lines represent the historical threshold values, as indicated (i.e., very low, low, moderate, high, or very high relative risk of severe disease).
*The y-axis uses a log scale and shows the risk of severe disease relative to a reference period of low incidence that occurred from June 1, 2023 through July 31, 2023. A relative risk equal to 1 indicates similar risk of severe viral disease as the reference period; a relative risk greater than 1 indicates higher risk of severe disease and a relative risk of less than 1 indicates lower risk of severe disease.
Data Sources: PHO Laboratory Information Management System; Ministry of Health Bed Census Data

Citation

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